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Deepwater Ventures:

Organizing for Gulf of Mexico Well Construction Operations

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Deepwater Ventures:

Organizing for Gulf of Mexico Well Construction Operations

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Deepwater Gulf of Mexico well construction operations are some of the most challenging and expensive operations in the E&P industry; not only does the outer continental shelf of the Gulf of Mexico present the distinct environmental challenges of hurricanes and loop currents, its geologic profiles can include such challenges as salt, tar or pressurized zones. To overcome these challenges technology is being pushed to its operational and mechanical limits but technology advances can only accomplish so much without the presence of capable personnel. In the E&P industry, human resources are becoming more limited due to the “Big Crew Change”; a disproportionate relief of the retiring Baby Boomers by Generation X workforce that now requires Generation Y assistance. Regardless of the aforementioned, operators venture out into deepwater with hopes to capitalize on the recently discovered attractive development and exploratory opportunities, but to do so they must organize and properly develop their internal well construction organization in a manner that all

members are capable to address the challenges as they come. Therefore, team organization is an operator's priority, a challenge that should be addressed through common project management practices. This paper parallels the project management practices to establish the appropriate organizational structure for an operator's deepwater well construction group, manage the human resources to properly delineate responsibilities and to structure their staff management processes to acquire, develop and manage personnel in a manner scalable with the operator's expansion agenda.

TABLE OF CONTENTS_Toc280221276

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

For any company, venturing into their industry's 'new frontier' in an effective manner is essential to remain competitive. New frontiers are those that pose the next challenges within a large spectrum of associated risks and rewards. In the oil industry one new frontier is deepwater and ultra-deepwater Gulf of Mexico. As the consumption and cost of crude continue to increase, production in the mainland decreases and government restrictions remain, more and more operators are stepping to the plate venturing deep into the Gulf of Mexico.

Oil & Gas operators venture deep into Gulf of Mexico to meet their strategic goal; increase reserves. To tap these reserves requires the efficient development of existing fields and/or new discoveries of economically producible hydrocarbon reservoirs via complicated well construction projects. Well construction projects demand operators manage the work and people involved to realize their intended goal; proper management of these is the link between the strategic goal and the tactical work performed. Therefore, project management that results in the efficient planning and execution of development and exploratory well construction affects the bottom line.

This paper will discuss the application of project management techniques and strategies for the foundation and development of operators' deepwater Gulf of Mexico (DWGOM) well construction organization. Discussion of technical details and procedural tactics pertaining to the planning, execution, contracting, HSE and regulatory practices are not addressed in this paper. However, the focus will be on recommendations for the foundation of an efficient and productive internal organization.

DWGOM WELL CONSTRUCTION

Deepwater well construction projects are complex endeavors with many associated technological, geological and environmental challenges (Appendix B) which are further intensified by the expected limitations on human resources resulting from industry's disproportionate relief for the retiring Baby Boomers by Generation X workforce that will require the assistance from the entering Generation Y workforce to fill the labor gap; an effect known in the industry as the "Big Crew Change". Regardless of these challenges, recently discovered geologic plays with considerable reserves along with government incentives offer operators great opportunities in DWGOM. Also, speculated energy reform in Mexican legislature may open up and attract operators to DWGOM (Appendix B).

For any operator, deepwater well construction projects entail the largest portion of capital expenditures and equally hold substantial cost risks. Operators new to deepwater lack experience and might consider turnkey contracts as a viable option to eliminate the associated risks. However, these risks are a function of well complexity which increases in conjunction with water depth, measured depth, vertical depth and geologic uncertainty. Deepwater wells require more casing strings to reach final depth making the well more complex and they also require numerous completion assembly components (Appendix D). Wellbore complexity also increases the drilling operational costs, tangible costs, and operating time; in completions, cost is driven by the specialized equipment and processes necessary to maximize production in the harsh deepwater environments. Considering average operational costs of $1M per day and typical drilling and completion durations of 100 and 45 days respectively; wellbore complexity, associated operating costs and limited information in DWGOM increases cost overturns risks and ultimately the eliminate turnkey alternative. Therefore, to plan and supervise the execution of deepwater well construction projects operators need to assume the full responsibility for their operations.

This means operators must minimize their risks of costs overturns by developing an internal, fully functional and capable well construction organization; one that maintains operational control and internally creates and retains the know-how, processes and capabilities to pursue future projects. Internal well construction organizations are imperative for partnerships to work and partnerships are the norm in deepwater projects as these mitigate the associated economic risks. Therefore, the development of an internal drilling organization is a fundamental step in the foundation of DWGOM well construction operations.

DWGOM ORGANIZATIONAL PRACTICES

Venturing DWGOM operators include foreign operators with vast offshore experience outside the GOM and American independent operators transitioning from land and shallow water operations into deepwater. In order to efficiently transition into their new area of operations these operators must establish their deepwater working groups accordingly. However, the challenges associated with DWGOM prevent direct transfer of existing operational organizational frameworks and knowledge from land, shelf and/or other deepwater regions of operation. Also, the structures of existing DWGOM well construction organizations vary from operator to operator and therefore there is no golden path to an optimal organizational structure of DWGOM operations. Consequently, venturing DWGOM operators will often fail to thoroughly define and establish their organizational structure in order to expedite the commencement of their projects; a practice that focuses on short-term results and does not provide any long-term advantages. This leaves operators vulnerable to undergo several organizational structure changes within their well construction organization, continually re-defining their related work processes as operations expand; actions complicated by the fact that DWGOM well construction organizations are composed of varied multifunctional teams necessary for specialized expertise in operations. These practices bypass project management fundamentals and do not optimize nor serve as a guideline for the firm establishment of deepwater operations. Regardless, DWGOM operators can function and manage operations under such floating structures, so long as the number of projects or operated rigs for DWGOM operations is one or two. More projects require more rigs and this might result in operational confusions as a large multifunctional organization operating multiple rigs will be difficult to manage and susceptible to costly inefficiencies in operations; all detrimental for long term objectives.

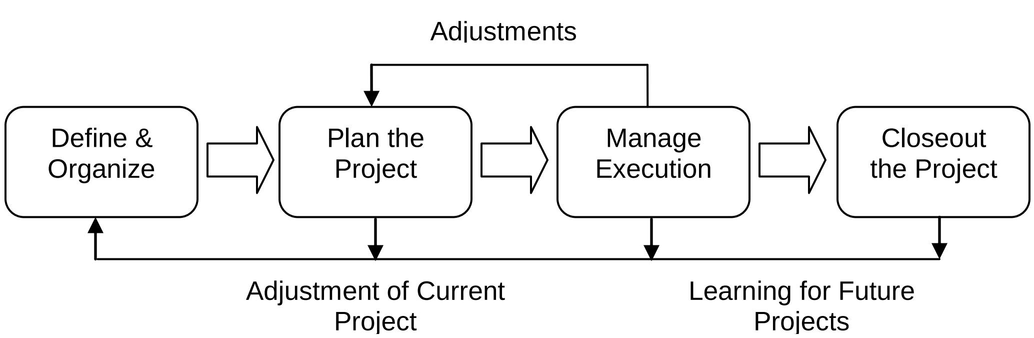
In DWGOM, ten year operational leases alleviate the pressure on operators to actively and consistently pursue every project/lease on their agenda. This extent of available time for operations means strategic schedules are subject to change as projects are re-prioritized possibly changing the working groups' plans and personnel. Changes and movements of personnel between functional groups results in loss of knowledge and practices when the organization operates under a floating structure. When operators execute projects under floating structures the roles, responsibilities and necessary competencies between functional groups are inconsistent. Operators will fall back on general standards or inherent personal understanding for these in their well construction groups; these are minimum standards dictated by industry and may not always be up to par with current deepwater expectations. Operators should strive to explicitly define and develop internal roles, responsibilities and pertinent competencies that assure deepwater well construction operations exceed minimum requirements. Without explicit delineation of these, they are subject to change or cause confusion between group members. Inconstancies in roles, responsibilities and competencies are detrimental for both short term and long-term endeavors.

THE PROJECT MANAGEMENT PROCESS TO ORGANIZE FOR DEEPWATER OPERATIONS

As previously mentioned, deepwater well construction projects involve the cross-functional collaboration of groups from different specializations. The particular functional groups referenced on this paper are: Geology/Exploration, Reservoir Engineering, Drilling and Completions Engineering, Operations, Logistics & Contracts and HSE. Each of these groups has their own dedicated personnel, specific responsibilities, deliverables and standards but as a cumulative well construction organization, these groups must be organized to work collaboratively and ensure proper work flows. Moreover, within the organization of each group the personnel competency requirements vary. Personnel and competency requirements will shift with escalating operations. Escalating operational shifts in personnel is addressed through a practical scalability plan that adjusts the group's organization, deliverables and responsibilities as the operator contracts more rigs to expand their well construction operations. For these groups, an appropriate organizational structure will be identified as well as the pertinent organizational roles, responsibilities and competency standards. These factors will enable an outline for the organization's acquisition of team members, development of same and a generalized scalability expansion plan for the organization.

Project management is the formal management discipline where by projects are initiated, planned, executed, monitored, controlled and closed according to a systematic, repeatable and scalable process. Projects, as defined by the Project Management Book of Knowledge (PMBOK), are temporary endeavors undertaken to create a lasting outcome; these endeavors have repetitive elements but are fundamentally "unique" in the work involved; all characteristics applicable to well construction projects. The project work itself is performed by a project team or organization and the project management process enables these organizations to draw upon the individual strengths of the team members by providing an efficient infrastructure for defining, planning and managing the project work regardless of the structure or temporary nature of the organization.

This project management process is itself a series of steps typically represented by the "project management process model" shown below:



The steps in the project management model are further broken down into following subtasks:

1. Define and Organize
    - Establish the organization
    - Define the project parameters
    - Plan the project framework
    - Assemble the project definition document
2. Plan the Project
    - Develop the Work Breakdown Structure (WBS)
    - Develop the schedule
    - Analyze resources
    - Optimize tradeoffs
    - Develop a risk management plan
3. Manage Execution
    - Launch the project
    - Collect and evaluate status information
    - Evaluate the project progress
    - Update cost and schedule estimates
    - Plan & take adaptive action
    - Control Change
4. Closeout the Project
    - Evaluate the project for success

- Recommend project management improvement practices
- Analyze and record cost, duration and configuration data
- Handoff the product

In the following sections, the first step of the “Define and Organize” stage of the project management process, “Establish the Organization”, will be discussed in reference to the establishment of DWGOM well construction organizational structure, pertinent roles, responsibilities and competencies to enable the foundation the organization’s scalability plan. Commonly employed organizational structures in the oil and gas industry will be assessed to determine the appropriate organizational structure for deepwater well construction projects. From this organizational structure, the multiple organizational roles pertinent to the well construction process will be defined with their associated responsibilities and competencies. The outline of associated competencies will enable foundation of the organization’s team acquisition, professional development and scalability plans. The conclusions and recommendations made will reflect the amalgamation of project management practices and existing industry practices for performing deepwater well construction projects and organizing multifunctional groups into collaborative organizations. These recommendations are intended for operators venturing into DWGOM and/or new members to existing well construction groups.

DEFINING AND ORGANIZING THE WELL CONSTRUCTION ORGANIZATION

The Harvard Business School states that “to effectively complete a project we need to know the objectives, the people who will work as a team to achieve them and the manner in which they will be carried out.” (McCann) Clear definition of these project objectives, organization and the procedures dictating how well the team members coordinate the project activities are essential before the beginning for project success; the contrary increases the project’s tendency to fail.

The following sections will compare the various organizational structures to identify the appropriate structure for deepwater well construction operations. Identification of such structure must be complimented by the appropriate human resource management process which defines the pertinent organizational roles, responsibilities and competencies for the internal deepwater well construction group members. The human resource management deliverables facilitate the staff management plan which entails organizational team acquisition, professional development and the scalability plans.

ESTABLISH THE ORGANIZATIONAL STRUCTURE

The organizational structure is defined as “a pattern of relationships that links the technology, tasks, and human components of the organization, to ensure that the organization accomplishes its purpose” (Guidemond, Have, &

Knoppe, 2010). The purpose of the project organizations can be structured to manage people or to manage the project work. In developing the appropriate structure for these internal well construction groups the focus remains on the group's goals, resources, actions and people. These are four of the five parameters that Hal Rabbino deemed important in his paper "Optimizing the Organizational Design of a Typical Upstream Exploration and Production Company" applied on the well construction groups. In general the goal is not to structure the organization just to drill and complete wells within time and budget but to thrive at it; to increase efficiency and effectiveness in order to stay ahead of the competition. For this to be achieved the following must be addressed when outlining the group's organization:

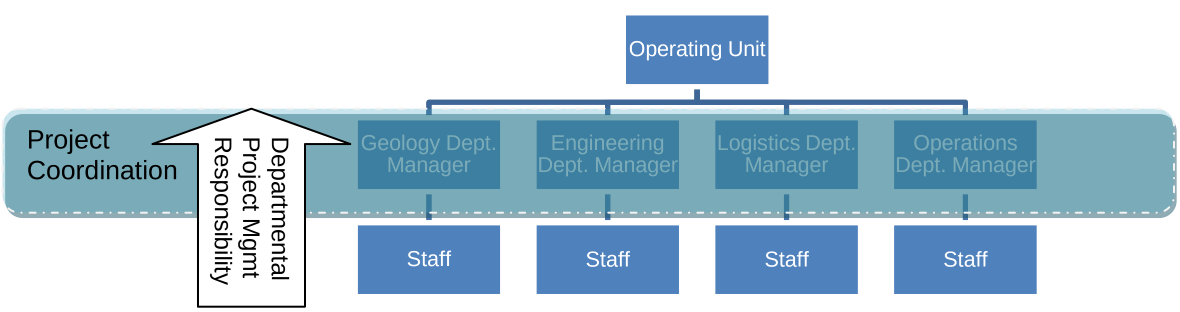
1. Allocations of people to achieve optimum productivity;
2. Communication of objectives, processes and best practices;
3. Interfaces and interactions between the separate groups in the organization;
4. Appreciating how activities in each group affect each other group and the organization as a whole; and
5. Consistent approaches for staff selection, development and training for all functions;

In deepwater operations, the focus of the organization is to manage the work because of the high costs, long project durations and uncertainty but the focus should be on managing the people considering the expected human resource limitations impending the “Big Crew Change”, the multifunctional nature of the organizations, the industry’s notorious employee turnover and personnel changes in between groups or departments associated with deepwater wells. If the people performing the work are managed well, the work will be done right and to manage the people the organization must be structured right. To develop the right organizational structure that supports deepwater well construction projects has never been easy as there is no royal road for such and there are various organizational structures to pick from: the functional, projectized and matrix organizational structures.

FUNCTIONAL ORGANIZATION

The functional organizational structure, organized around primary functions or specialized departments i.e. engineering, operations, geology etc., dominated the petroleum industry in the 1940’s and lasted for about 30 years (Guidemond, Have, & Knoppe, 2010). Figure 1 presents an example of a functional structure in case of deepwater well construction group.

Figure 1 - DWGOM Functional Structure

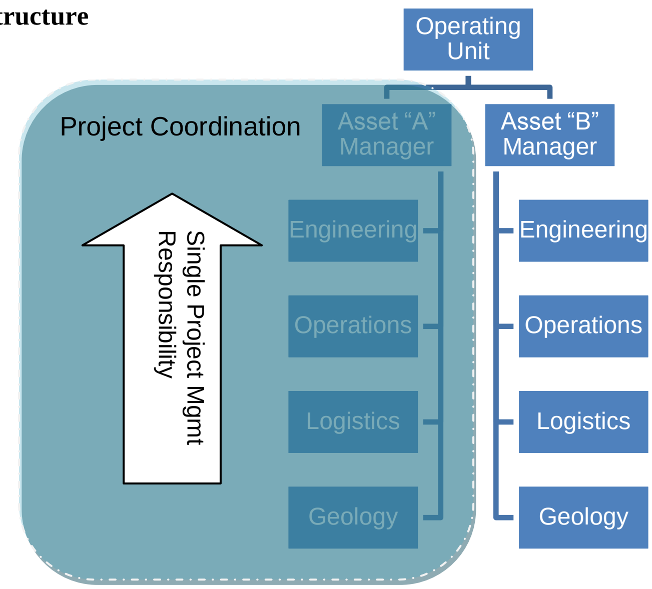


Projects assigned within the functional groups are easily managed but extra work is required to coordinate and manage projects that span across functional departments. The structure's vertical integration allows efficient use of collective experiences to build expertise. However, drawbacks of this vertical integration are that it requires an escalating decision making process; it inhibits communication across departments and disciplines; and prevents integration of departmental deliverables until you get to the top of the vertical ladder. For deepwater well construction projects, especially in the execution phase, decisions need to be made in a timely manner, at any time of the day and often requiring collaboration between the various specialized departments involved. The high costs of deepwater operations dictate decisions are made quickly with input from all stakeholders to mitigate operational cost overruns. The escalating decision making process and compartmentalized communication structure leaves the functional structure vulnerable to considerable time delays and possible departmental conflicts in the execution phase.

PROJECTIZED ORGANIZATION

The projectized organizational structure is a structure where dedicated functional departments exist within the projects. This organizational structure was adopted by the petroleum industry in the 1990's by organizing around assets. Multifunctional asset teams were created to concentrate on exploiting hydrocarbons in a specific asset; in deepwater operations, the assets can be field development projects and/or exploration endeavors. However, it's probably more appropriate that the projects be categorized by Rig since Rigs dictate the projects that can be executed. Figure 2 presents an example of a projectized structure in case of deepwater well construction group.

Figure 2 - DWGOM Projectized Structure



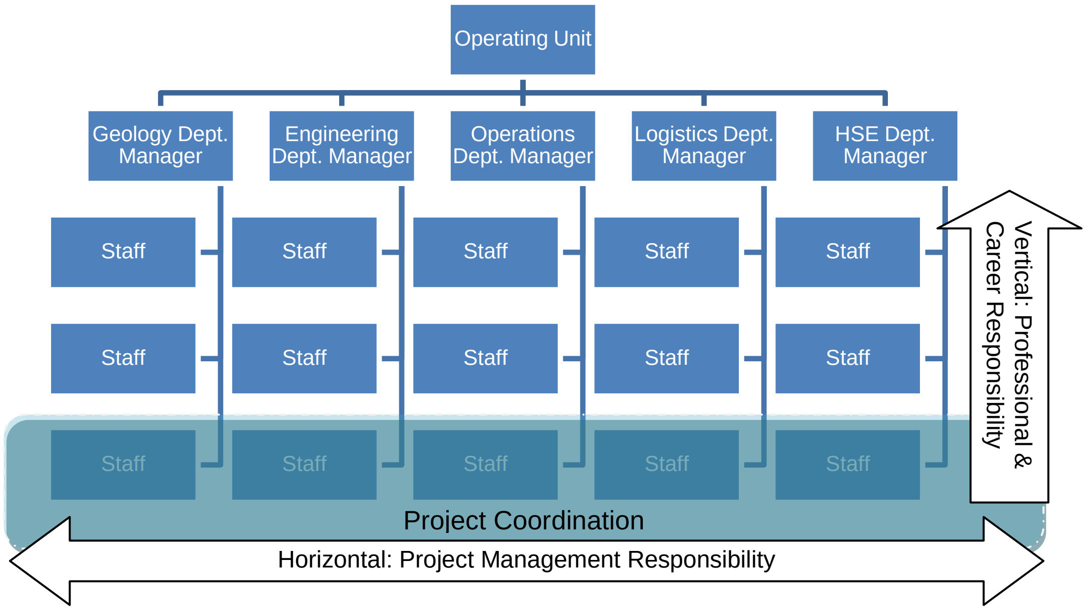
Projectized structures are appropriate for organizations that work on large, long term projects. However, these are susceptible to inefficient redundant operations among multiple projects because of the isolation of the specialized departments within each asset / project. This isolation also makes it difficult for engineers of the same background to share knowledge or for senior engineers to provide support for junior engineers. Projectized structures can potentially work well for new venturing deepwater operators when the organization is small and resources are not limited. As the organization grows, projects multiply and additional rigs and personnel will need to be contracted to satisfy the needed resources of each project. With limited availability of capable rigs and qualified personnel in the deepwater industry, organizations need to maximize the use of their resources. Overall rig availability is outside the control of operators; therefore, operators need to maximize use of their contracted rigs and personnel efficiently. Under the projectized structure, the efficient use of personnel and rigs across multiple projects becomes difficult to accomplish. Additionally, the isolated nature of projectized structures further prevents personnel from sharing knowledge, technology or innovating project management practices with members of other project teams. The deepwater industry is a fast moving and technologically innovative industry and personnel in well construction teams need to share their knowledge across the whole well construction organization to continually improve project management practices through technology application and thus maintain a competitive edge.

MATRIX ORGANIZATIONS

The matrix based organization is a decentralized organization required when projects span functional boundaries. Under the matrix organizational structure, workers belong to the functions / departments and are assigned to projects by the functional manager who controls implementation and is also responsible for long term administration issues. The project manager assigns, monitors, and coordinates the project team and controls the scheduling of tasks.

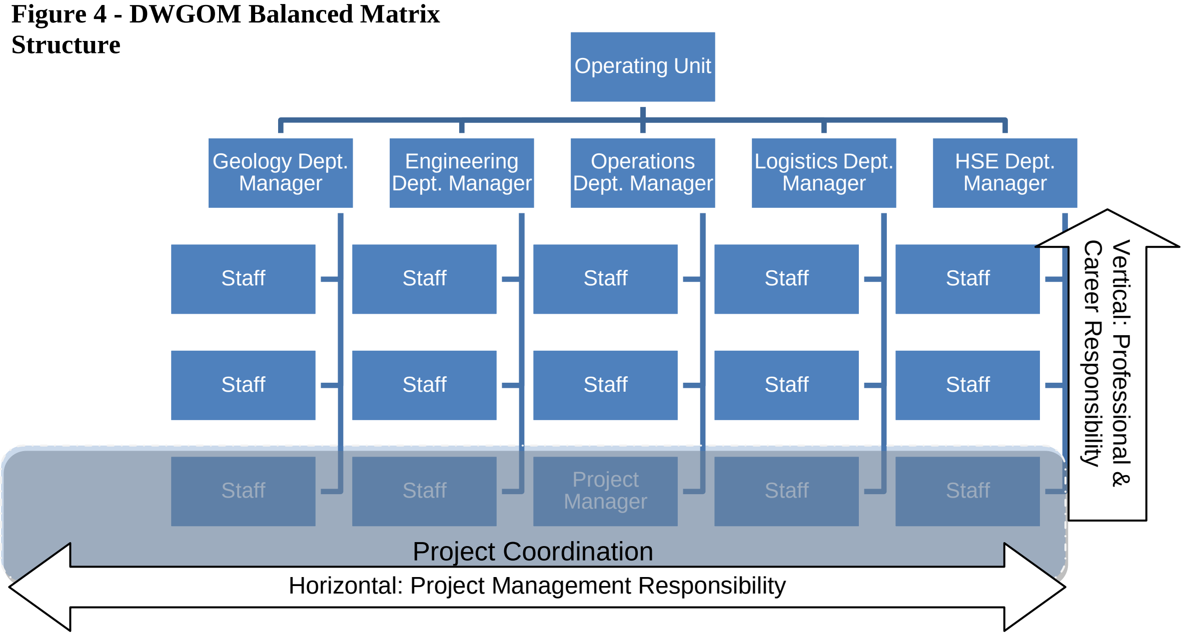
The essence and main problem of the matrix structure is that every person working on the project has two bosses (dual authority) – and if these people work in more than one project they will have even more (Verzuh, 2008). The dual authority structure consists of a functional line and a project line usually represented as a grid; with a vertical flow that provides professional / career responsibility in functional departments and a horizontal flow of project managerial responsibility (Guidemond, Have, & Knoppe, 2010). This dual authority system supports cross-departmental coordination, communication, collaboration and accountability and thus makes the matrix structure the most complex form of structural coordination mechanisms. The PMBOK classifies the different blends of matrix organizations into: weak, balanced and strong matrix organizations each differing in the authority level of the project manager. In the weak matrix the project manager role is more of a coordinator or expediter than a manager. Figure 3 presents an example of a weak matrix structure for a deepwater well construction group.

Figure 3 - DWGOM Weak Matrix Structure



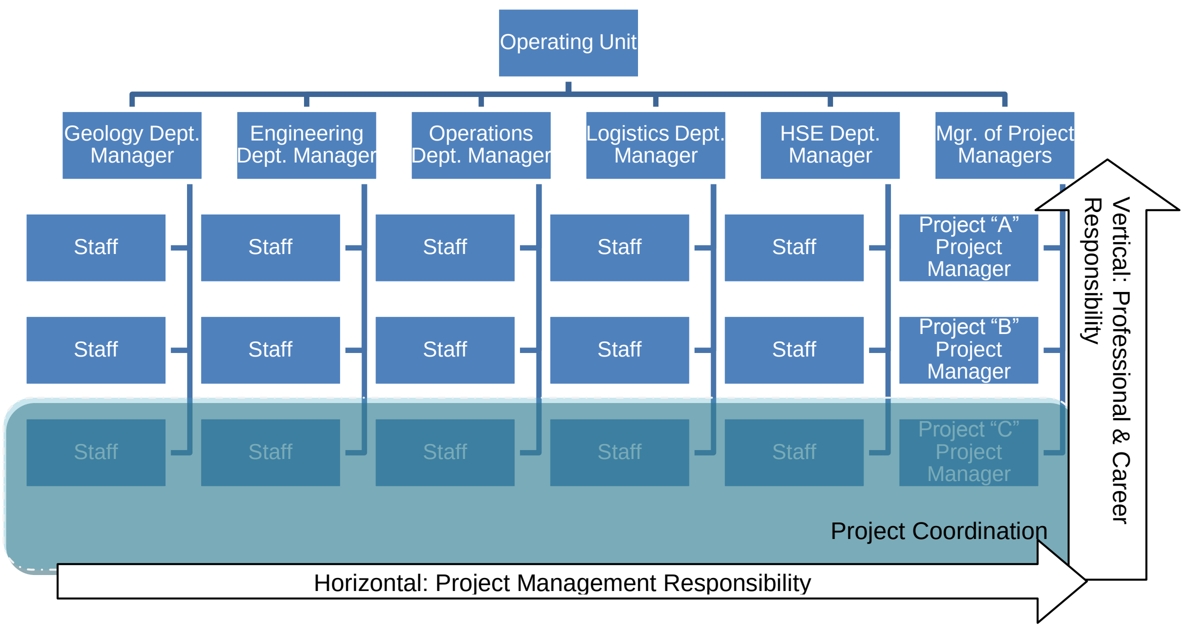
In the balanced matrix the need of a project manager is recognized yet it is not given full authority of the project. Figure 4 presents an example of a balanced matrix structure for a deepwater well construction group.

Figure 4 - DWGOM Balanced Matrix Structure



In a strong matrix the project manager has considerable authority over the project and a full time project staff. Figure 5 presents an example of a strong matrix structure for a deepwater well construction group.

Figure 5 - DWGOM Strong Matrix Structure



Deepwater well construction projects are complex in nature, requiring the involvement and expertise from different specialized departments to effectively plan and execute the drilling and completion activities. Thus, the appropriate organizational structure for well construction organizations must allow cross-functional project collaboration, encourage collaborative learning, and provide a projectized decision making process. The structure that provides these is the strong matrix organization.

Under a strong matrix structure, a deepwater well construction organization allows maximum use of specialized personnel from any and all participating departments. Doing so mitigates resource constraints among multiple projects and as operations scale up. This also means providing a full time project staff and part time contributors that can effectively, actively and simultaneously participate to multiple ongoing projects. This maximizes expertise in all operations and prevents overlapping functions, redundant work and inefficiencies. Such cross-departmental collaboration, communication and accountability occur from planning to execution until the well is handed over to the production department.

A strong matrix structure also provides a decentralized decision making process where decisions are made by the group closest to actual operations. This is appropriate for deepwater operations as decision making is most critical in the execution phase. In deepwater well construction projects, a full time operations project manager is responsible for the management and decisions affecting cost and schedule in the execution phase; drilling and/ or completion. The specialized departments involved contribute expertise in the decision making process and dictate the implementation of pertinent decisions made. The project manager is given considerable authority over the field operations team responsible for the implementation of the decisions made.

THE HUMAN RESOURCE MANAGEMENT PROCESSES

Establishing the strong matrix structure as the appropriate organizational structure for deepwater well construction projects is the precursor of the human resource management processes. The human resource management processes are human resources planning, acquisition of the project team, developing the project team and managing the project team. For foundation purposes, the focus of the paper will be on the first three human resource management processes which according to the PMBOK encompass:

1. Human resource planning by identifying and documenting pertinent organizational roles, responsibilities and reporting relationships as well as creating the staff management plan;
2. Acquisition of the human resources needed to perform the project(s)' work; and
3. Development of the personnel via improvement of competencies and interactions between personnel to enhance project performance;

ROLES & RESPONSIBILITIES OF THE ORGANIZATION

In matrix structures, the dual authority system can lead employees to have conflicting loyalties and often feel confused about their identity within the organization (Guidemond, Have, & Knoppe, 2010). This is a problem that is intensified as the matrix organization grows. The lack of roles and responsibilities is one of the underlying reasons for employees' identity and identification problems in matrix structures; therefore, indentifying the organizational roles is the first step to further enable the well construction organization the maximum use of its staff to ensure technical quality and detail. Considering that venturing deepwater operators will initially operate under a lean organization, the roles are identified on a one well project, one rig scenario. The roles pertinent to well construction projects are: the project manager, project team leaders, and project team members, manager of project managers, functional managers and functional staff. In the oil & gas industry these roles already exist and will be referred to in their typical industry equivalents shown on Table 1. Emphasis on role definition will be those involved in execution, building around rig operations.

Table 1 - Well Construction Equivalents of Strong Matrix Organizational Roles

Strong Matrix Role / Position	Well Construction Equivalent
Project Manager	Rig Superintendant
Project Team Leaders	Company Men
Project Team Members	Well Site Staff: Well Site Engineers, Technical Specialists / Engineers, Logistics Coordinators, Field Geologists and HSE Field Representatives.
Functional Staff	Office Staff: Geologists, Engineers and Logistics Coordinators.
Manager of Project Managers	No equivalent in most well construction organizations.
Functional Managers	Departmental Managers: Engineering (Drilling / Completion), HSE, Geology, Reservoir and Operations Managers

The term “Rig Superintendant” is the equivalent to the term “project manager”; this developed from the fact that well construction projects are undertaken on a per rig basis. The Rig Superintendant is primarily responsible for the coordination of the well site staff to perform the drilling and completion operations in accordance the official well construction program and all pertinent regulatory, HSE and company policies. To achieve this, he/she must maintain consistent communication with the Company Men, well site staff and pertinent specialized office staff. A Rig Superintendant must be “big picture” oriented, a motivator, a leader, organizer, administrator, and effective communicator but most of all a decision maker. He/she must effectively work with the Company Men, well site staff and office staff to track issues for continual lessons learned, manage conflicts to continue work, manage project scope and make timely adjustments; all highly critical in deepwater operations due to its high level of uncertainty and the cost sensitivity. He/she must also manage the associated risks in drilling and completion which in DWGOM operations are also highly critical due to geological uncertainties and relatively unexplored locations in drilling operations and consistent use of latest technology in completion operations. Lastly, he/she must behave ethically and professionally responsible; characteristics that highly scrutinized in deepwater operations due to the recent Deepwater Horizon incident.

The term “Company Men” developed as means to identify the Team Leader in the execution of drilling and completion operations simply because they are the official representatives of the operating company on the rig. Typically, there are two Co. Men on the rig at all times to supervise operations; a Day and a Night Co. Man. Under a two Co. Men supervisory system, the day Co. Man is the lead supervisor on the rig and is usually the more experienced one. The latest trend among DWGOM operators is to operate under a three Co.

Men system where a floating Lead Co. Man that concentrates on planning and on-site project management. These Lead Co. Men also assist Day and Nigh Co. Men in critical operations. Due to the recent Deepwater Horizon incident, project supervision has become priority #1. For this reason alone, a three Co. Men system is highly recommended; they add extra supervision and expertise and the extra costs they entail are minimal in the big scheme of the projects. It's important to note that Co. Men are not the "Boss"; they are a direct extension of the Rig Superintendant and the operating company in the field. They are primarily responsible for supervision of the proper execution of procedures in the well construction program in accordance with regulatory, HSE and company policies. They are the link between the Rig Superintendent and the field subordinates: the well site staff, the drilling contractor and participating service partners. They report and communicate progress to the Rig Superintendant. Co. Men must be action oriented with vast field experience; lead by example and ensure everyone contributes and everyone's voice is heard. They must coach and mentor less experienced personnel and be a negotiator between service providers, drilling contractor and the operating company to maintain good morale and continuous, safe and productive operations in difficult times or when performance is unsatisfactory.

For DWGOM operators, the typical internal well site staff consists of well site engineers, logistics coordinators, HSE representatives, field geologists and intermittent specialized personnel, primarily for completion operations. The well site engineers are responsible for the development of the execution procedures from the general well construction program. They also serve as extensions of the operating company assuring proper engineering practices are followed and operations do not violate any regulatory, HSE or company policy. They assist the Rig Superintendant in their general responsibilities in assessing operation performance, continually exploring methods to optimize operations and recording lessons learned etc. Predominantly, they are engineers by discipline and may possess minimal field experience; enough to contribute and perform their tasks but insufficient for supervisory responsibilities. The logistics coordinators are basically responsible for the logistical coordination of equipment and personnel to and from the rig necessary for operations. They must coordinate such in conjunction with Co. Men and well site engineers to minimize standby charges and/or prevent late arrival. Oftentimes they are responsible for creating and distributing daily progress reports; a task Co. Men and well site engineers can also be responsible for. HSE representatives are primarily responsible for ensuring all pertinent regulatory, HSE and company policies are complied with. They must address, record and communicate any related incidents. They must also develop programs that prevent such incidents in the future. The field geologists are primarily involved only in drilling operations. Their general responsibilities are to report geological drilling progress and analyze the geological formations as these are drilled to asses target progress, predict upcoming geological markers or hazards or reassess the project as a whole.

They communicate with office personnel, well site engineers and Co. Men to address geologically related issues that affecting drilling performance. The specialized personnel are part-time participants oftentimes necessary in completion operations because these may involve new technology, additional coordination or require specialized support. These can be personnel specialized in the different phases of completion operations: handling of completion fluids, perforating, stimulating and/or installation of completion assemblies. They are not quite as necessary in drilling operations as long as these do not involve completely new or relatively specialized technology outside the conventional drilling processes. While Co. Men and well site engineers may be capable of performing these operations without the additional support, specialized personnel provide additional expertise in these critical operations. As mentioned before these personnel can provide logistical coordination assistance necessary in completion operations as these require extensive amounts of specialized equipment and thus are susceptible to logistical errors. In short, these specialized personnel assist the Rig Superintendent, Co. Men and well site engineers perform their tasks when such involve new or unconventional processes or technology. Service personnel and the rig contractor crew are external staff that perform important project work but are under their own management structure and thus outside the scope of this paper.

The functional staff in essence is the operating company's office staff primarily responsible for the well construction projects' planning processes and deliverables and technical assistance in execution. This staff may include expert HSE advisors, drilling engineers, completion engineers, reservoir engineers and geologists along with logistics and contracts coordinators. Their responsibilities include and are not limited to the initial project scoping, project requirements, geological reviews, drilling and completion engineering designs, vendor contracting and cost & schedule forecasts, etc. Once the planning deliverables are complete and the project moves on to execution; the office staff participates in the drilling and completion operations as remote expert advisors and may at times become the specialized personnel of the well site staff. In general, their participation in the execution phase may only be part time as they may also be full time participants in the planning and closing processes of multiple projects.

The “manager of project managers” does not have an equivalent term in deepwater oil & gas as this position is not common in the industry. However, such a role can exist in organizational structures where operators’ objective is to implement Collaborative Work Environments (CWE). CWEs are “a forum, which is specifically created to integrate people, processes, technology and facility for improved cross-functional and virtual collaboration, learning, and high quality fast decision making” (Guidemond, Have, & Knoppe, 2010). CWEs have been implemented by several operators because these allow people to work collaboratively regardless of distance, making better decisions, faster, thereby enabling enhanced productivity and delivering operational performance; all objectives of deepwater operations. Guidemond, Have, and Knoppe recommend two variations of the matrix structure to petroleum companies wanting to implement CWEs. In these recommendations the manager of project managers is referred to as the CWE Team Leader and his/her level of authority differentiates the recommendations. The Guidemond, Have, and Knoppe recommendations are:

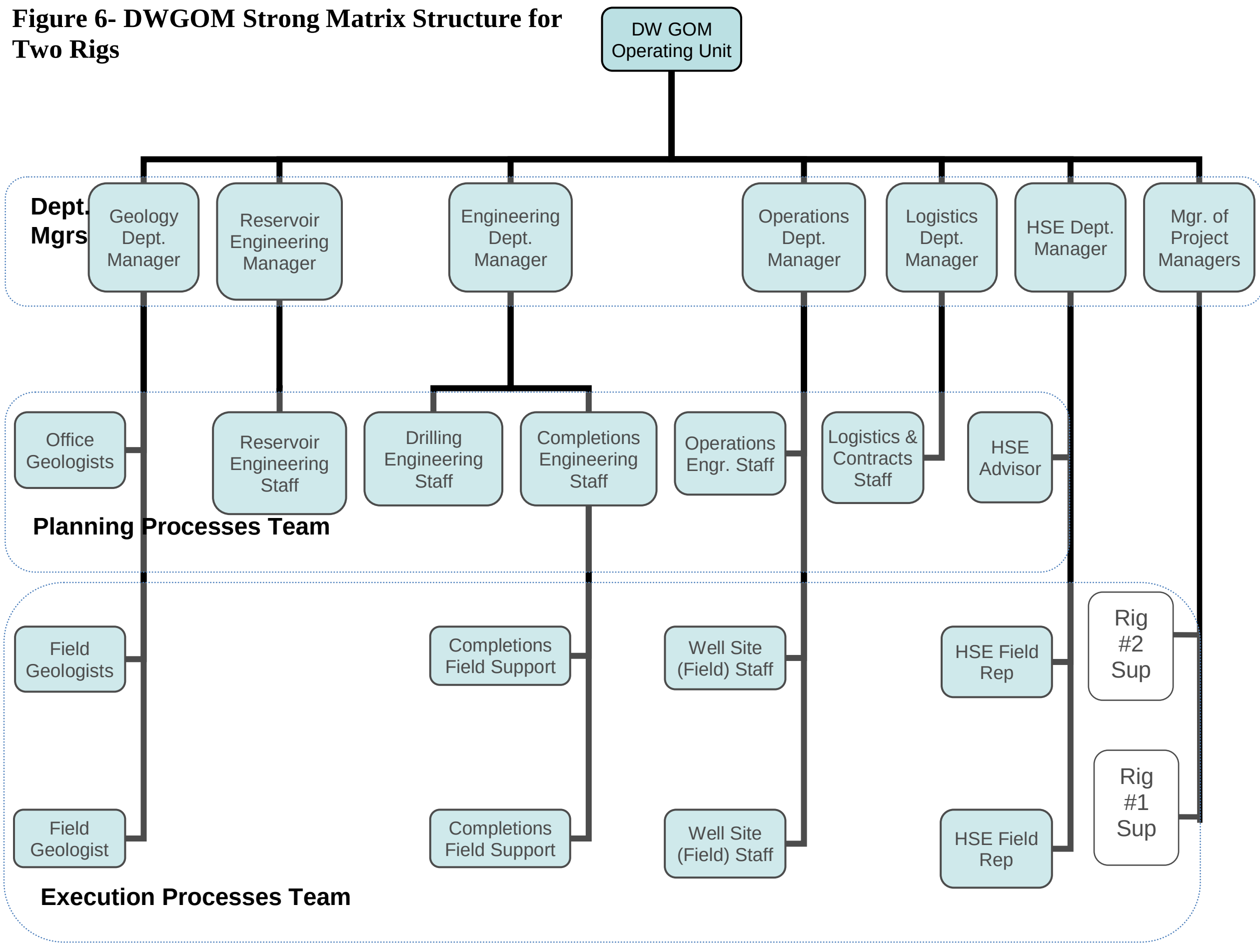
- Recommendation “A”: The CWE team leader is appointed to provide integration between the several departments involved in the CWE. He/she is responsible for the ‘project management’, and therefore for the ‘project owners’ i.e. Project Managers / Rig Superintendants. However, he/she has no formal authority over staff of different departments involved in the CWE; formal authority remains at the department managers. In case of priority setting, preference is given to develop departmental specialization, instead of executing projects. The balance of the matrix structure would lean more towards the functions, as distinct from projects.

- Recommendation “B”: Puts the CWE Team Leader at the same hierarchical level as the departmental managers. In fact, the CWE Team Leader is placed outside the CWE itself to have formal authority for executing projects. If the CWE Team Leader is placed at the same hierarchical level as the departmental managers, a better balance between developing functional/departmental specialization (functional line) and executing projects (process line) will occur. In case of disagreement from CWE Team Leader and departmental managers, their Manager needs to decide whether priorities are on the functional or process line. If CWEs are implemented, the role of the CWE Team Leader needs serious consideration.

If an operator only has one rig under contract to perform its projects, as is common with new deepwater operators, there is no need for a manager of project managers in the organization. Under this scenario resources may not be limited and at the disposal of the Rig Superintendant to use in the well construction's execution processes without disrupting departmental functions. Under the one rig scenario competition for resources can be negligible and therefore authority and hierarchy level the Rig Superintendant is irrelevant. However, when an operator expands and multiple rigs are operated, a manager of project managers should be part of the organization. The level of authority of the manager of project managers in deepwater operations is highly significant when multiple projects are executed simultaneously which will be the case with multiple rigs under contract. Simultaneous operations can result in competition for scarce resources between projects. All Rig Superintendants cannot be at the same hierarchical level as the departmental managers; so when resources are brought to question, tradeoffs will need to be made. Having the manager of project managers at the same hierarchical level as the departmental managers provides the Rig Superintendants equal means to voice their opinions and needs when priorities are being re-assessed by the entire well construction organization. Therefore, recommendation “B” provides the authority balance between the manager of project managers and departmental managers in a strong matrix structure beneficial in deepwater operations. The CWE Team Lead role description in recommendation “B” is therefore the fitting role of the manager of project managers in deepwater well construction projects. Additionally, the manager of project managers is also responsible for the definition and improvement of the project management processes; serves as a liaison between Rig Superintendants and departmental managers; and has overall responsibility for all well construction projects. In being responsible for all well construction projects he/she must select Rig Superintendants, prioritize projects when necessary and monitor overall drilling and completion operations.

Finally, the functional managers are more commonly referred to as departmental managers. These respective departments include the Engineering, HSE, Geology, Reservoir, Logistics & Contracts, and Operations departments. Note that the engineering department can either be two distinct departments: the Drilling Engineering and Completion Engineering at the same hierarchical level as the other departments or these can be departments inside the general Engineering Department. All of these departments are primarily responsible for planning and executing the work of the well construction planning processes in their respective specializations; developing the implementation of new technologies; and training their respective employees. Some of these departments are only part time participants in the execution processes. As part time participants they may be referred to for technical expert advice or decisions and are responsible for efficiently allocating personnel within different projects. Figure 6 presents an updated example of the strong matrix structure for DWGOM operations.

Figure 6- DWGOM Strong Matrix Structure for Two Rigs



The operator must compliment all of aforementioned organizational roles with detailed descriptions of their respective authority level and responsibilities in order to establish the chain of command in operations. For all of the pertinent organizational roles, authority level must be outlined with regards to but not limited to the request and application of resources, level of decisions that can be made and authority to sign official documents such as approvals and regulatory forms. Explicit outline of authority levels is even more critical between the departmental managers, manager of project managers and Rig Superintendants. Their respective authority levels must be delineated with regards to power over departmental subordinates participating in the execution process of well construction operations, implementation strategies in critical operations, quality acceptance of equipment, services or operations and response to project variances. If the delineation of authority is vague amongst these parties decisions will require more effort to get made. When authority levels are clear, the chain of command is also clear and this mitigates inter-departmental authority clashes over competing interests and efforts addressing problems that break through functional boundaries.

Another complicating factor in the organization's chain of command is the explicit description of the organization's departments' and its members' responsibilities. In the planning and execution processes, these responsibilities are the specific tasks the departments and individuals are expected to perform in order to complete the project's activities. The PMBOK recommends that general outlines of individual member responsibilities be specified in text-oriented formats providing not only the responsibilities but also individual authority; explicit delineation of the individual authority and responsibility leads to accountability. The stage gate nature of well construction projects requires multiple and consistent cross-departmental collaborations between members belonging to different departments; collaborations too exhausting to describe in text format for every member involved. Addressing these collaborations is important to outline relationships and accountabilities in the well construction process. Project participants must know who they are dependent on to properly perform their work and who depends on them. To address these issues, a responsibility matrix is ideal for showing cross-organizational interactions (Verzuh, 2008). A responsibility matrix is a tool that clarifies the relationships between organizational units (departments/members) and project tasks. It provides a "big picture" view of the well construction process, concisely depicting authority, responsibility within the organization and communication channels thus allowing each departmental manager or subordinate to understand their specific involvement and the involvement of others in such. The four steps required to properly set up a responsibility matrix are:

1. Listing the major tasks of the project. These major tasks are usually outlined in the projects work breakdown structure (WBS) and are usually listed on the vertical axis of the matrix;

2. Listing the stakeholder groups in such. The stakeholder groups or departments for well construction projects are listed on the horizontal axis of the matrix. It is appropriate, however, to put individual names on the matrix when a single person will be making the decisions or will be completely responsible for a task (Verzuh, 2008);
3. Coding the roles of the stakeholders. These codes indicate the level of involvement, authority role and responsibility of each stakeholder (Verzuh, 2008). Common codes include: Responsible (R), Participant (P), Initiates (B), Approves (A), Must be consulted (C), Provides input to (I), Receives output of (O) or Is notified (N); and
4. Incorporate the responsibility matrix into the organization's project rules. This means that once accepted all changes must be approved by those who approved the original version. The advantage to this formal change management process is that the project manager (Verzuh, 2008), the Rig Superintendant, is always left with a document to refer to in the event of a dispute;

Table 2 presents an example of a general responsibility matrix outlining the responsible and participating departments in a well construction project. The tasks noted in this matrix are those involved in the planning processes of a typical DWGOM well construction project; this is why the matrix stops at the start of the execution phase, "Daily Rig Operations". A similar responsibility matrix for the execution phase of well construction projects is recommended as it re-assures ownership of tasks, accountability and prevents costly communication breakdowns between departments. The coding in either matrix can be expanded to be more descriptive and delineate more accurately the individual department's involvement in the respective task. Expanded delineation of departmental involvement is more critical in the execution phase to outline the chain of command between the different parties involved in each task. For deepwater operators, the responsibility matrix is a simple tool with substantial benefits; its implementation mitigates breakdowns in the chain of command difficult to outline in individual text based description of responsibilities.

Table 2 - DWGOM Well Construction Responsibility Matrix

Well Construction Tasks	Geo	Engr.	Ops.	L & C	Serv. Partners	Res	HSE	Proj. MGMT
Initial G&G Review	R							
Right Scoping (Project Scope, Objectives, Value Drivers and Definition of Success clearly defined)	P	R	P					
PPFG		R			P			
Shallow Hazards	R				P			
Offsets Review		R	R					
Statement of Requirements	P	R	P					P
Risk Assessment - Technical and Financial	P	R	P			P		P
EP Submittal	R	P						
Final Geo Review	R							
Cost/Benefit Analysis for all options		R	P					P
Basis of Design		R	P					P
Casing Design		R						
Initial Well Cost Estimate		R						
Well Authorization - By MGMT								
Concept Freeze - By MGMT								
Procure Tangibles		P		R				
Front End Loading (with contingencies)	P	P	R	P				P
Vendor Selection (including rig)		P	R	P				P
Specific vendor services	P		R	P				P
Rig Audit			R				P	P
Initial well review with vendors		P	R					
Initial well review with partners		P	R					
AFE to Corporate		R						
AFE to partners		R						
APD submittal		R	P					
Well Plan – Initial		R	P					
HAZID/HAZOP			R					
Drill Well On Paper			R					
Technical Limits Session			R					
Well Plan – Final		R	P					
Peer Review			R					
Management of Change Plan			P					R
Safety Management Plan with vendors/rig			R				P	P
Knowledge/Learning Management Plan		P	R					
Document Control Plan		P	R		P			
Cost Control			P	R				
Communication Plan			R					
Daily Rig Operations	P	P	P	P	P	P	P	R

COMPETENCY STANDARDS

The expectations the organization has of its members' performance in operations are explicitly delineated in the roles & responsibilities. These, however, do not provide an explicit definition of the level of competence required from individuals expected to fulfill the roles. Competency refers to an individual's demonstrated knowledge, skills and attitudes performed to a specific standard (Institution of Engineers, Australia, 1994). Project team members must be more than competent to complete project activities; their performance is jeopardized if they do not possess the minimum of necessary competencies for the tasks at hand. Before the project team is assembled, the competency of every team member should be defined to insure the organization assembles a team fit for the tasks.

Operators oftentimes assign the technically challenging well construction operations to personnel with minimal competence levels when these complex operations require highly competent individuals able to perform the respective challenging functions. Operators venturing into deepwater, oftentimes, resource the personnel responsible for the planning and execution of drilling & completion operations from land and shallow water operating environments expecting these to meet the more technical demands of deepwater operations. These operators assume that drilling and completion capabilities can be easily transferred between the different operating environments. This practice applies mostly to experienced personnel and results from the industry's Big Crew Change. The limited pool of qualified personnel means longer searches for the right people, but operators want to expedite the search and assemble their well construction team to begin planning and executing projects; they want to reduce the time to market of their product. Also, operators who venture deepwater do so as a long-term endeavor. As such, they will recruit personnel with lesser levels of experience such as new and recent graduates. These younger team members are expected to provide basic assistance but most importantly to learn from experienced personnel and develop into the future geologist, engineers, managers, etc. responsible for the organization's future operations.

Regardless of the experience level, veteran and younger team members are expected to perform their respective tasks from operations inception and develop with the industry. The well construction organization, therefore, has to give much consideration to the definition of competencies desired from the well construction team members to pave the way for optimum performance. To develop the basic competence standards of each individual position in the well construction group, a thorough job analysis must be performed for each. The roles and responsibilities of each position have been identified; the job analysis takes these a step further to outline basic competency standards in terms of knowledge, skills, talents and behaviors (KSTBs):

- Knowledge refers to the factual or procedural information needed for performing a task acquired through formal or informal learning (Lewis, 2009). Knowledge competence is an individual's cognitive ability to perform a task; a competence metric that can be attained through education or training. Therefore, educational accomplishments serve as an indicator of expertise or minimum ability to perform job responsibilities. Well construction knowledge can be assessed by objective criteria such as years of related experience, degree of education level (e.g. Geology, Engineering Degrees) and/or pertinent certifications (Professional Engineer/ Geologist Certifications);

- Skills refer to the level of proficiency at performing a particular task (Lewis, 2009). Skills are a combination of knowledge and talent and those deemed necessary to excel in well construction projects can be quite subjective. Regardless of the subjetivity in skills it's safe to argue that technical, command and coordination skills are a fundamental basis for well construction projects. Technical skills are specialized derivations of knowledge skills. These are the knowledge and ability of specialized subjects and/or techniques involved in the well construction process. Technical skills for well construction processes are discussed in further detail later in the paper. Complimenting techincal skills are command skills. Command skills are decision making, situational awareness, commmunication, teamwork and leadership skills; all necessary for the management of unexpected events under high pressure of time, risk and undertainty, the likes of well construction operations. Command skills are recognized as the minimum requirements for individuals and teams dealing with unexpected events (Chrichton, Henderson, & Thorgood, 2004). The defintion of decision making, communication, teamwork and leadership skills is self explanatory and well understood in general; situational awareness, however is not. Situational awareness skills entail the ability of an individual to percieve what's is happening, understanding what it means, and projecting this forward into the future by gathering and sharing information between team members. Lastly is coordination skills, which is also self explanatory but quite essential due to the high volume of logisitics involved in well construction operations;

- Talents are special or natural ability or aptitude applicable to the pertinent tasks (Lewis, 2009). These are innate abilities not attainable through training such as being a fast learner or a team builder. Like skills, talents necessary for well construction are subjective, but talents essential for multifunctional teams responsible for complex operations are motivating, team building and fast learning. For those involved in contracts, negotiating talents are a plus;
- Behaviors are actions / activities influenced by demeanor or personality required to successfully perform a task. Some can be developed and some cannot (Lewis, 2009). These are also subjective, but some examples of behaviors beneficial for deepwater well construction projects are: organized and attentive to detail. Overlooking the smallest of details or failing to maintain an organized schedule can easily translate into serious cost setbacks in operations. Other behaviors valuable in deepwater well construction projects are collaborative, reliable and

investigative. Collaboration is characterized by personal exposure, open arenas, fast decision making, information transperancy, and multi discpline and distributed teams (Roland & Moldskred, 2008). Thus, the multifunctional personnel in the deepwater well construction organization need to expose themselves to the problems encountered in an open and transparent environment to develop a decision quickly. The distance between offshore and onshore team members requires all members collaborate for the common goal. The basic definition of reliable is to be dependable in achievement. For the purposes well construction operations, reliability is the objective achieved by a set of behaviors consistently seeking ideal perfection but never expecting to achieve it. Essentially, personnel must practice consistent attention to those performing the work in operations in anticipation of failure to prevent the team from drifting into complacency and reduce the probability of failure resulting in reliability; the consistent application of situational awareness skills. Most errors are made by competent people, not by equipment malfunctions or process issues, therefore, on the rig, where many important operations are performed by third party personnel, well site personnel must be preoccupied with failure prevention not necessarily success. If failure is prevented, the probability of success increases. Investigative bahvior can be an asset in well construction as this eables personnel to associate the many elements involved and question the way challenges are currently being addressed or new challenges affect existing technology and processes. This behavior promotes the search for new and innovative designs, practices and techniques that have not been integrated into the processes of the organization (Millheim, 1989).

The operator must determine the applicable KSTBs necessary to perform each position's tasks. Once the operator determines each position's basic competency standards in the well construction team, these need to be compiled in manageable and presentable format. There are various alternatives to how the operator compiles and presents these. Table 3 presents a sample compilation of basic KSTBs for the positions in a DWGOM well construction team.

The KSTBs shown on Table 3 are just a simplified example that an operator can modify or expand to fit each position according to company culture and environment. To ensure optimum job fit and performance, the technical skills necessary in well construction projects can be delineated for each position accounting for the expected level of responsibility of each. Considering that different positions in well construction groups can involve similar levels of responsibility or competence, positions can be grouped into levels of competence derived from expected levels of responsibility as shown on Table 4. For each level of competence, the technical skills pertinent to well construction projects can be broken down into specialized units of competency that include but are not limited to: well control, well site operations & supervision, loss avoidance, HSE, well design & planning, rig selection & procurement logistics, and well construction / project management (PetroSkills, 2010). Each of these units of competency has associated elements of competency that vary with level of competence. These units of technical competency with associated elements can be outlined with examples of performance criteria for each level of competence as presented by Table 5 and shown in more detail on Table 6 for the intermediate level of competence.

Table 3 - DWGOM Well Construction Organization Member KSTBs

<table>
<tr><th rowspan="2">Positions</th><th colspan="2">Knowledge</th><th rowspan="2">Skills</th><th rowspan="2">Talents</th><th rowspan="2">Behaviors</th></tr>
<tr><th>Experience</th><th>Education / Certifications</th></tr>
<tr><td>Departmental Managers</td><td>>20</td><td>Bachelors in Related Discipline, MBA, Professional Cert.</td><td rowspan="3">Command / Technical</td><td>Team Builder</td><td rowspan="13">Organized, Reliable, Cooperative, Investigative, Attentive to Detail</td></tr>
<tr><td>Office / Planning Engineers</td><td>>15</td><td>B.S. Engineering, P.E. Cert.</td><td rowspan="2">Fast Learner</td></tr>
<tr><td>Office Planning Geologists</td><td>>15</td><td>Minimum: M.S. Geology</td></tr>
<tr><td>Logistics & Contracts Personnel</td><td>>5</td><td>Bachelors in Business / Logistics</td><td>Command / Coordination</td><td>Good Negotiator</td></tr>
<tr><td>Manager of Project Managers</td><td>>20</td><td>B.S. Engineering / MBA P.E./ P.M. Cert.</td><td rowspan="9">Command / Technical / Coordination</td><td rowspan="4">Motivator, Team Builder</td></tr>
<tr><td>Rig Superintendant</td><td>>15</td><td>B.S. Engineering</td></tr>
<tr><td>Lead / Day Co. Men</td><td>>10</td><td>Preferable B.S. Engineering</td></tr>
<tr><td>Night Co. Men</td><td>>5</td><td>Preferable B.S. Engineering</td></tr>
<tr><td>Well Site Engineers</td><td>0 – 5</td><td>B.S. Engineering, E.I.T Cert.</td><td rowspan="5">Fast Learner, Team Builder</td></tr>
<tr><td>Completions Field Support</td><td>>10</td><td>B.S. Engineering</td></tr>
<tr><td>Field Geologist</td><td>>10</td><td>B.S. Geology</td></tr>
<tr><td>Field Logistics Coordinator</td><td>>5</td><td>Bachelors in Business / Logistics</td></tr>
<tr><td>HSE Field Reps</td><td>>10</td><td>B.S. Safety Engineering</td></tr>
</table>

Table 4 - Levels of Competence

Basic Level	<u>Acquired the principals:</u> New / Trainee Engineer. Level, knowledge & understanding with some basic skills
Foundation Level	<u>Optimize solutions</u> Well Site Engineers, Night Co. Men, Jr. Engineers (predominantly executing)
Intermediate Level	<u>Guardians of integrity</u> Lead/Day Co. Men, Rig Superintendants, Senior Engineers, or Specialist (authorize or execute a specialist activities)
Specialized Level	<u>Experts</u> Departmental Managers. Considered company expert.

Table 5 - DWGOM Technical Skills Competence Table

COMPTENCE LEVELS	BASIC		FOUNDATION		INTERMEDIATE		SPECIALIZED	
WELL CONSTRUCTION SKILLS UNITS OF COMPETENCY	Elements of Competency				Examples of Performance			
WELL CONTROL								
WELLSITE OPERATIONS / SUPERVISION								
COMPLETIONS AND WORKOVER OPERATIONS								
LOSS AVOIDANCE								
HSE ISSUES								
WELL DESIGN / PLANNING								
RIG SELECTION, PROCUREMENT LOGISTICS								
WELL CONSTRUCTION / PROJECT MANAGEMENT								

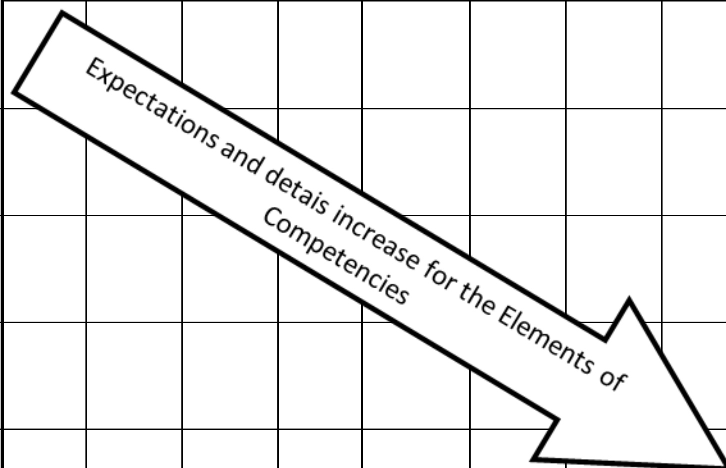


Table 6 - Detailed DWGOM Technical Skills Competence Table

SKILL LEVEL	INTERMEDIATE	
UNITS OF COMPETENCY	Elements of Competency	Examples of Performance
WELL CONTROL	Predict shallow water zones.	Hazards and risks presented by shallow seismic horizons identified and accessed. Preventative and mitigating techniques implemented.
WELLSITE OPERATIONS / SUPERVISION	Familiar with rig positioning operations and quality assurance.	The management processes, contingencies and redundancy required to prevent and eliminate driveoff or drift off incidents well explained.
COMPLETIONS AND WORKOVER OPERATIONS	Familiar with Smart Completions	The sequence and key troubleshooting procedures involved in the installation of deepwater smart completion systems.
LOSS AVOIDANCE	Perform Hazard & Risk analysis.	Hazards presented by narrow pressure margins, shallow flow, gas hydrates, cold temperature and supply/logistics etc accurately assessed. Associated risks and potential recovery time and contingency required for specific operating environments identified and ranked.
HSE ISSUES	Familiar with Oil-based mud management techniques.	Key operational and loss control issues (e.g. cuttings management, gas cut mud) to be accounted for during drilling operations described and outlined.
WELL DESIGN / PLANNING	Design deepwater fluid requirements.	Suitable fluids selected taking into consideration the narrow operating margins of pore/fracture pressure, effects of cold temperature hydrates, Gumbo formations, and wellbore stability.
RIG SELECTION, PROCUREMENT LOGISTICS	Familiar with Deepwater Rig Components	Key rig equipment specifications necessary to drill in waters over 5000 ft e.g. Top Drive load limits, Cuttings handling equipment etc.
WELL CONSTRUCTION / PROJECT MANAGEMENT	Meet management and well objectives	Well and project objectives are linked to the overall business strategy of the company understood and described correctly. Drilling operational, drilling and well engineering processes required to meet management expectations well explained and instructed.

STAFF MANAGEMENT

An organization's staff management plan describes when and how resource requirements will be met; it can be formal or informal, highly detailed or broadly framed, based on the needs of the project(s) (Project Management Institute, 2004). The staff management plan is a dynamic effort, continually changing throughout the project(s), directing ongoing team member acquisition and development actions. The processes involved in the staff management plan can vary by discipline and project(s)' needs; processes of interest in the establishement of well construction organizations are the acquision of the project team members, development of these and the organizations scalability plan. With the organizational structure, general individual and departmental roles and responsibilities identified and detailed competency expectations defined, the final steps in establishing the well construction organization are to acquire and develop the team. The scalability plan provides the long term outline for future acquisitions and development of personnel.

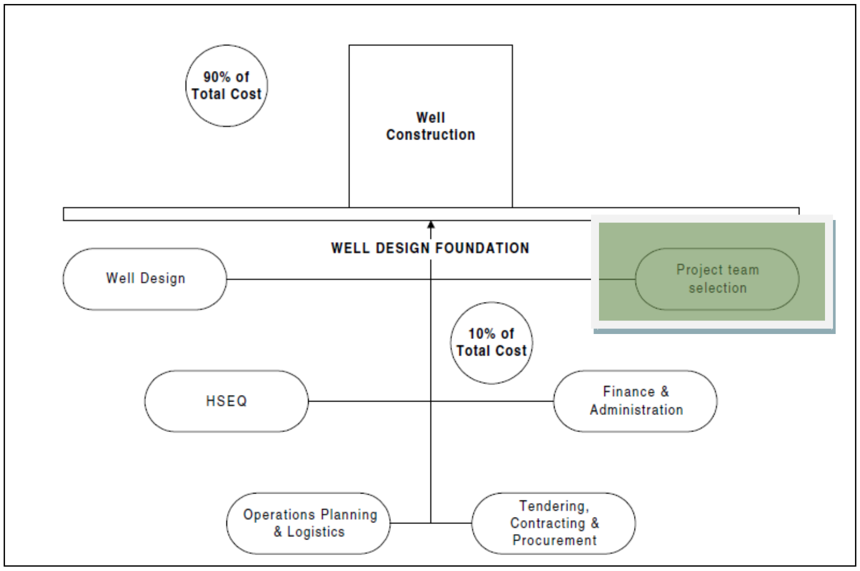
TEAM AQCUISITION

Acquiring the team is necessary for obtaining the human resources needed to complete the project and developing this team is necessary for improving the competencies and interaction of the team (The Project Management Institute, Inc., 2004). The key organizational roles in well construction projects have been identified. Assuming that venturing operators will commence operations with one rig under contract provides a basis for the organization's recruiting strategy. The competencies identified for each of these roles provide the selectivity standard for each position. Future staff acquisition needs will be dictated by the organization's scalability plan discussed later.

Considering the scarcity of qualified personnel in the industry due to the Big Crew Change, operators must invest time and resources in their recruiting processes. Without going into extensive details recommending appropiate recruiting strategies for new DWGOM operators, it is advised that operators create networks within industry and academia and promote collaboration between the technical departments in their well construction organization and their HR department to ensure not only that they acquire capable experienced personnel but that they attract capable new and recent graduates. The well construction team cannot relie on HR to be fully responsible for the recruitment of valuable techincal personnel; they must take an active role in the recruting process. At the very minimum, it’s important that they invest the time to develop Job Descriptions based on the defined roles & responsibilities and the pertinent competency standards of each as previously outlined. These are the starting point for the acquisition of personnel.

Regardless of the industry’s scarcity of capable personnel, new deepwater operators cannot afford to forgo selectivity. Project team selection is one of the six pillars for the foundation of well construction operations (Figure 7). Well construction foundation constitutes approximately 10% of the total well construction costs and its effectiveness is dependent exclusively on personnel; therefore their quality and compentence has a significant impact on operations (Marshall, 2001). Therefore, clearly defined competencies outlined in the manner previously described, provide clear cut standards for the selection of the best candidates for the open positions; these competencies were developed and agreed upon by the organization and they must be adhered to in the selection of personnel, otherwise they need to be revised by the entire organization

Figure 7 - Schematic of the "pillars" of the well construction foundation (Marshall, 2001)



It is important to note that new GOM operators may initially tansfer experienced personnel internally from their land, shallow or other international areas to fulfill critical roles in their new DWGOM branch. For local operators these personnel will have to adapt quickly to their new environemnt and expedite their development. If they can achieve this successfully it will provide long term benefits for the organization. For international operators, this practice entails an expatriate workforce necessary to establish and maintain a home base presence. The temporary nature of the expat workforce can be detrimental for long term objectives as their presense tends to be limited to five years on average. This causes a repetitive loss of expertise which operators need to prevent by capturing their knowledge in the organization and by properly managing the competencies of the new local personnel, especially newer team members.

Management of competencies, described in more detail in the next section, is a necessity for all venturing GOM operators.

DEVELOPMENT & TRAINING

Competency standards define the organization’s initial criteria for personnel selection, but once the team is assembled the organization must assure it remains competent. To remain competent, DWGOM operators must manage the team’s competencies to ensure experienced personnel keep up with technical advances in the industry and new personnel develop their technical skills efficiently. Competence management, however, is a process operators often deem it’s the responsibility of the individual employees, is ignored or considered something that will automatically occur. In actuality, competence management is the responsibility of the organization and one that demands considerable investment in and dedication from the operator. Like team member selection, competency management roots itself in the initial competencies defined, these provide the operator a starting point for their development and training programs, the tools of competency management. Training and development programs vary across the industry, some companies opt not to have or clearly define them; they view them as an expense when in reality they are an investment. The fast moving evolution of deepwater well construction processes and technology combined with the effects of the Big Crew Change demand operators efficiently train and develop their workforce. To achieve this, operators’ training and development programs must not only provide the workforce the means to attain necessary technical knowledge and skills but also provide the means to assess and demonstrate the investments made have positive results for the organization. In other words, organizations need a structured and verifiable approach to ensure personnel is competent; competency based training and structured mentoring are two tools used in the industry to achieve these goals.

Competency Based Training (CBT) is a systematic way of defining the standards required for a job and designing training programs using these standards (Tuedor, Osisanya, & Cuvillier, 2001). This type of training uses the identified competency standards to design training events. Training events are formal courses/classes that develop specific technical skills; but what determines what skills need to be developed? To determine the skills that need to be devloped, the well construction organization's management (departmental managers) must first perform a rigorous assessment of current competencies possessed by each member to create development plan for each individual member of the organization. These progression plans map out the technical competence gaps which dictate the skills to be developed to progress between the different levels of competence. Simply put, Table 8 must guide progression plans in CBT, the general steps to developing effective CBT are as follows:

1. Upon incorporation into the organization of an employee, the initial competence gap analysis dictates what training is necessary to develop the skills necessary to ascend to the next level of competence. The

technical competence gap analysis determines the learning objectives (kowledge, cognitive strategies, motor skills, and attitudes i.e.) of the training/courses the employee will take. These instructional activities must be designed so that they achieve objectives and develop competencies. The organization must also assure the learning objectives are specific and measurable to enable the assesment of the trainings effectiveness;

2. Upon completion of the training the individual employee is evaluated to assure the training was effective in developing the skills/competence. The methods of competentence assesment must be designed so that they consider learners' KSTBs and actual performance of competency. Means to achieve these are to incorporate tests/examinations and preferably certifications into the training followed by on the job application with pertinent performance assessment. Competency must be demonstrated on the job through carefully designed assesments tailored to the work environment. Furthermore, on the job application allows the employee supplementary learning by doing and links course objectives to performance at the workplace; it's the means to realize ROI through observable improvement in performance. Ultimately, assessment assures personnel progresses as planned;

3. The competence assessment determines whether the training objectives were met, if competencies were developed effectively and creates a new

competence gap analysis. If objectives were met, the employee moves up to the next level of competence associated with the new competence gap analysis performed. The process then repeats itself for every competence level (Figure 8). At the top level of competence, the competence gap analysis will most likely pertain to the acquisition of evolving technical knowledge.

CBT offers a results oriented, structured and holistic approach, focused on observable outcomes in the workplace. While venturing operators may not have the luxury of developing internal training /courses, there are different providers of such. To ensure these yield results, departmental managers must be actively involved in the development of the employee specific competency matrices, competence gap analysis and in training assesements via measurable expectations and application. Consistent assessment of competencies ensures effectiveness of training is reviewed. It's important to note that for recently graduated engineers, managers must be cognizant that they do not have the skills necessary for the job; that they are at a malleable (Figure 9) stage and must take advantage of the fact that they are still institutionalized in and demand a structured learning environment. If done correctly, the structured results oriented training with measurable outcomes and assesments will translate into performance improvement and cost savings.

Figure 8 – CBT Training / Assessment Loops for New Graduates and Experienced Personnel (Aggour, 2007)

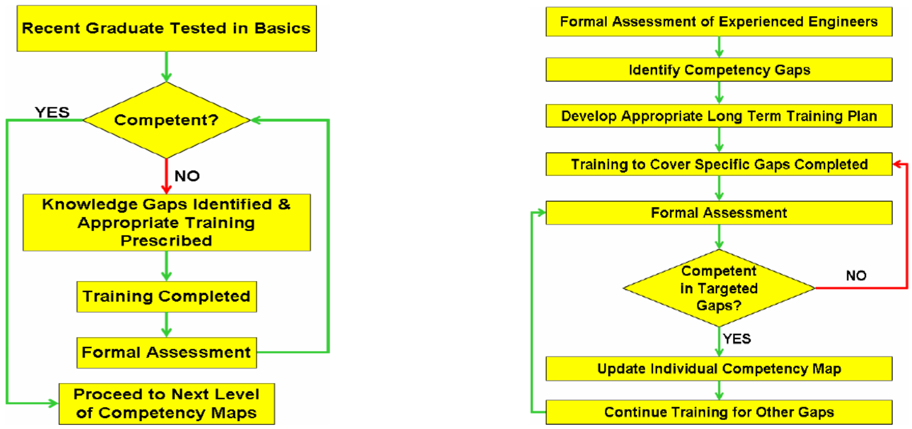
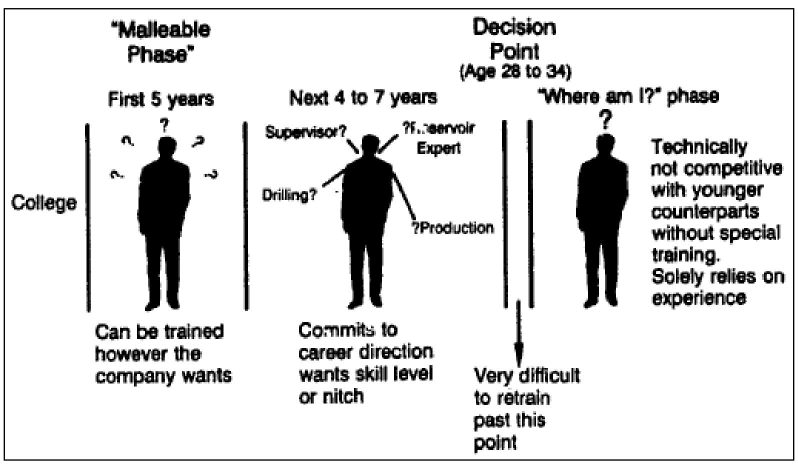


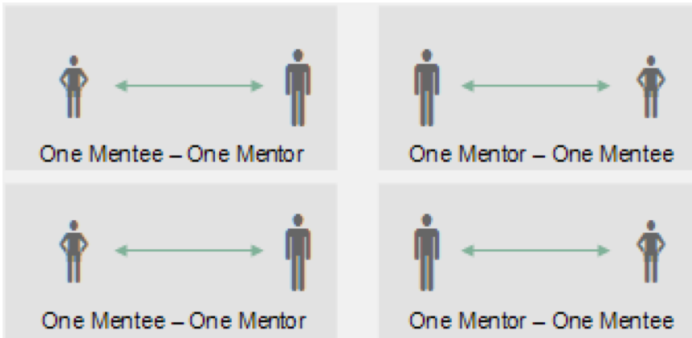
Figure 9 - Developmental / professional stages of engineer (Millheim, 1989)



Similar to CBT, structured mentoring focuses on the development of critical competencies; it bridges the gap between classroom and the job. Mentoring is guidance in application and is fundamental in on-the-job application of formal training. It's a tool that is grossly underused or unavailable within many new operators, but since mentoring enables the transfer of explicit and tacit knowledge from one generation to the next, mentoring is critical to mitigate the effects of the Big Crew Change. Structured mentorships are individualized and customized processes where experts assume mentor roles to transfer critical knowledge to less experienced mentees and guide the mentee through a well-structured curriculum towards the mastery of specific professional objectives (Aragon, Han, & Rousseau, 2008). Like CBT, structured mentorships are based on clear and measurable goals driven by competence gap analysis and measurable assessments and guided by a map of knowledge and skills to be transferred. It requires the identification of appropriate knowledge transfer techniques and the development of toolkits with resources, activity plans, job aids and evaluation/assessment instruments. These mentorships are complimentary to CBT, particularly in the on-the-job application of training and in general applicable to personnel in the Basic and Fundamental competence level as their autonomy is not fully developed until the intermediate competence level. The length of these mentorships should dependent on the time it takes to reach the intermediate competence level. The curriculum, specifically tailored for the individual employee, is dependent on the competence gap assessments until the intermediate competence level is reached. The benefits structured mentorships provide the venturing DWGOM operator are that they are well-organized with collaborative components, complimentary to the organizational structure that can be based on any of the three basic mentorship models:

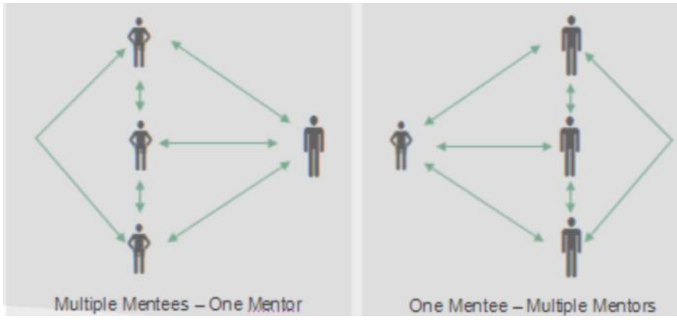
I. The standard / traditional model of one-to-one relationships between mentor and mentee;

Figure 10 - Standard / Traditional Mentorship Model (Arango, Han & Rousseau, 2008)



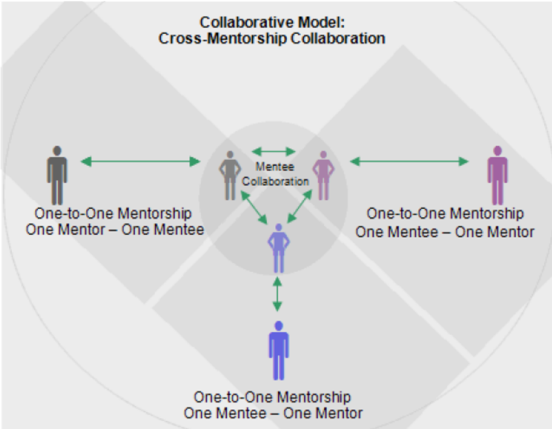
II. The networked model that allows one mentor to work with any number of mentees and enables mentees to receive the guidance of multiple mentors;

Figure 11 - Networked Mentorship Model (Arango, Han & Rousseau, 2008)



III. The collaborative model that enables multiple mentors and mentees to interact collaboratively but each mentorship relationship is a one-to-one relationship and each mentee receives a personalized mentorship experience.

Figure 12 - Collaborative Mentorship Model (Arango, Han & Rousseau, 2008)



The applicability of each model is dependent on the size of the organization and the competence level of the mentees. Regardless, considering the multifunctional environment of deepwater well construction organizations and the collaborative nature of the strong matrix structure, the collaborative model should be implemented from commencement of well construction operations. One-to-one relationships should exist in each department to enable mentees from different departments to be mentored in their respective function while at the same time collaborate and share knowledge with mentees from the same and other departments. While mentorship programs will be appealing to the incoming personnel, the experienced personnel oftentimes need encouragement to devote themselves in it as mentors. This can be addressed by making involvement in the mentorship programs a criterion for performance incentives based how well they mentor the younger generation. Ultimately, both CBT and structured mentoring requires commitment from management as they are responsible for organizational performance and effective training improves organizational performance.

SCALABILITY PLAN

With time, the organization will grow, operations will expand and experienced personnel will retire while younger personnel develop. Combination of the tentative timeline for expansion of operations, Well Construction OBS and outline of necessary competencies facilitates the development of an operator's scalability plan. Knowing the necessary personnel and competency needs to plan and execute well construction projects; operators can assess their personnel needs on a per Rig basis as priority as these personnel cannot assist with multiple projects then with office personnel as these can work multiple projects. While it's unlikely, an operator's target is to organize and administer its training and development programs to develop existing personnel in accordance with its scalability timeline. In other words, to develop personnel to the necessary levels of competence in time to assume more demanding roles and thus mitigate the training of new personnel into the company's culture, policies and procedures. If hiring is necessary, the competency tables facilitate the hiring criteria for each position.

CONCLUSION & RECOMMENDATIONS

The recent events surrounding the Deepwater Horizon incident have placed deepwater well construction operations at a pivotal point of their existance. This incident has brought light to the challenges involved in deepwater well construction and skepticism of the industry's ability to address these challenges. Current regulations and operational practices are being criticized and scrutinized resulting in major reform of regulatory and operational practices as well as reorganization of the particiapting parties.

As the industry reflects and assesses their internal well construction organizations' ability to address the challenges they must insure their organization fulfills the following (Figures 13 & 14):

1. The organizational breakdown structure emphasizes the importance of the execution processes, promotes cross-functional collaboration and maximizes personnel resources, which in this paper a strong matrix organization is recommended to achieve these;
2. The roles, responsibilities and authority levels of the pertinent stakeholders, participant groups and group members are clearly defined and formally established in text formats and via a detailed responsibility matrix as official project documents of the organization;
3. The organization emphasizes the collaboration of HR and Well Construction functional departments to acquire and develop their team members to insure competent people are undertaking the challenges at

hand. This entails clear definition of pertinent competency expectations based on team members' respective roles & responsibilities then consistently managing the individual competencies in a measurable and structured manner. In this paper, Competency Based Training and Structured Mentoring were recommended as efficient means to manage team member competencies;

Figure 13 - Summary Flow Chart of Deepwater Well Construction Organizational Practices

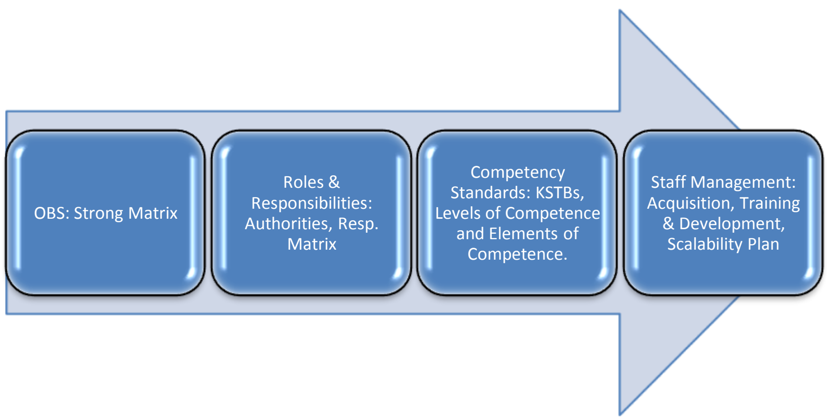
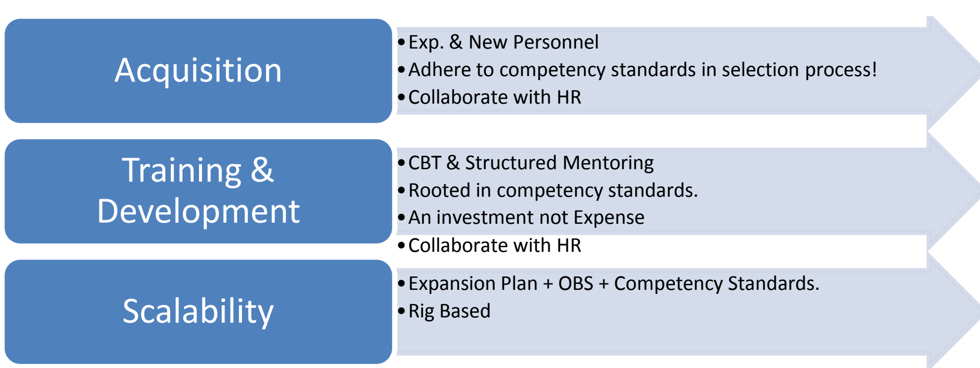


Figure 14 - Summary of Personnel Management Recommendations for Deepwater Well Construction Organization



Deepwater well construction projects are synonymous to deep pockets, their high costs and complexities press the groups involved to firmly establish their organization to overcome the associated challenges in the most efficient manner possible. Daily operational costs exceeding USD$1M per day or USD$10 per second literally put a dollar value to the phrase ‘every second counts’ and demonstrate why drilling and completion operations are the greatest expense for operators. More importantly these figures emphasize why operators must address the organization of the well construction groups to meet strategic goals. The bottom line on strategic goals is money and strategic goals demand a strategic organization. The appropriate organizational structure outlining roles and responsibilities complimented by recommended capabilities specific to GOM well constructions promotes the following:

1. Mitigation of negative consequences associated with ‘trial and error’ efforts;
2. Prevention of inconstancies associated with the continual reinventions of the organization;
3. Higher level of proficiency among the different stakeholders in the well construction processes; and
4. Optimization of well construction processes to meet or exceed expectations.

Therefore, a guideline for the establishment of the well construction organization is imperative. All of the aforementioned provides such based on project management standards, with an intended paradigm of success and positive long-term results.

APPENDIX

APPENDIX A - DEEPWATER AND ULTRA-DEEPWATER GOM OVERVIEW

Generally speaking, the water depths in which GOM exploration and production operations take place are divided into three ranges: shallow water, deepwater, and ultra-deepwater. Shallow water operations are those in up to 1,000 ft of water; deepwater operations are those in water depths greater than or equal to 1,000 ft but less than 5,000 ft; and ultra-deepwater operations are those in water depths greater than or equal to 5,000 ft. For the purposes of this paper, the term "deepwater" will reference both deepwater and ultra-deepwater operations unless otherwise specified.

Historically, DWGOM production began in 1979 and has expanded since, both into deeper waters and in terms of technological advances. However, this deepwater expansion has not been consistent because of the associated operational uncertainties, challenges and costs. Notwithstanding the challenges, government incentives and technological advances have prompted the economical extraction of hydrocarbons from the Gulf's prolific fields in deep and ultra-deep waters. These days, leases in DWGOM are an attractive asset for established and emerging operators and competition for them is on the rise to secure a foothold on the potential profits.

APPENDIX B - DWGOM CHALLENGES

After an operator acquires a lease and determines there is a need to drill a well in such, the operator will plan and execute the well construction processes. In DWGOM, the planning and execution well construction processes pose particular environmental, technical and resource availability challenges that must be addressed to ensure success. These challenges are not isolated variables, they are all interrelated.

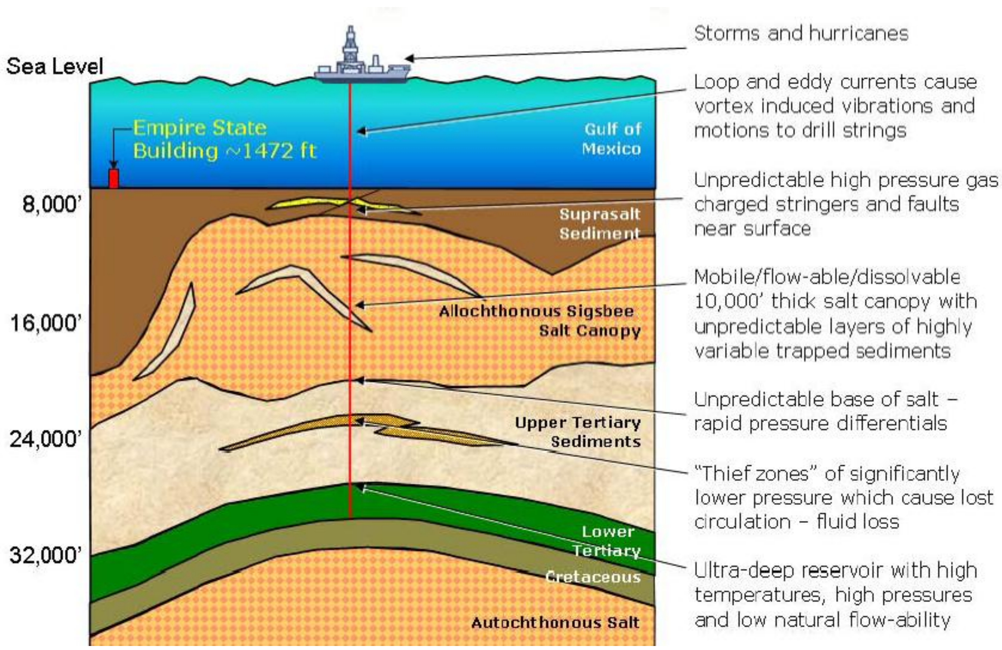
The environmental challenges associated with deepwater operations are combination of geology, water depth and regional meteorology. Geologically, the areas where exploration and development deepwater projects are located can contain a combination of the following:

1. Shallow water hazards;
2. Problematic formations such as salt, tar or "thief" zones;
3. High pressures;
4. High temperatures;
5. Deep reservoirs; and/or
6. Tight sandstones;

The deep water environment creates several challenges for well construction operations. The first challenge associated with water depth is the scarce availability of capable rigs to operate at these depths. Most of the existing capable rigs are under extended contracts and while operators press contractors for new builds, demand has not been able to be matched by production schedules. Water depth not only limits the rigs available but also the information available. There are not many wells drilled in deepwater and those which are oftentimes are not within proximity of each other; this limits the information available for planning purposes and elevates the level of uncertainty in execution. Another challenge associated with water depth is its effect on operations and engineering. As water depth increases, so does the vertical and measured depth of the well. With increased water and measured depths, operational costs will increase as well due to the extended lengths of time spent handling equipment in and out of the wellbore. The necessary drilling fluid for operations and contingency measures also increases with increases in measured depth and water depth. Deepwater wells utilize synthetic based drilling fluids which is an expensive but necessary ingredient in deepwater well construction operations. As vertical depth increases so does the hydrostatic pressure imposed downhole, combined with water depths reduces the operational pore pressure-fracture gradient window which complicates operations.

Meteorologically, operators in the GOM are vulnerable to hurricanes, a challenge particular to this region of operations. Hurricanes in the GOM are both unexpected and notorious for extended periods of non-productive time. Operators can plan to execute their well construction projects outside the "hurricane season" but complete avoidance of this risk is virtually impossible. The duration of the "hurricane season" (June – November), the limited availability of capable rigs, and the costs of these combined with organizational pressure to produce, demands operators execute projects year round when possible. Additionally in DWGOM, underwater loop currents can also add unexpected non-productive times. These are common and uncontrollable factors that can severely affect the cost and schedule of well construction projects. Figure 1 presents a summary of environmental challenges associated with DWGOM well construction projects.

Figure 15 - Summary of Deepwater and Ultra-Deepwater GoM Technical Challenges in Drilling (Close, McCavitt & Smith, 2008)

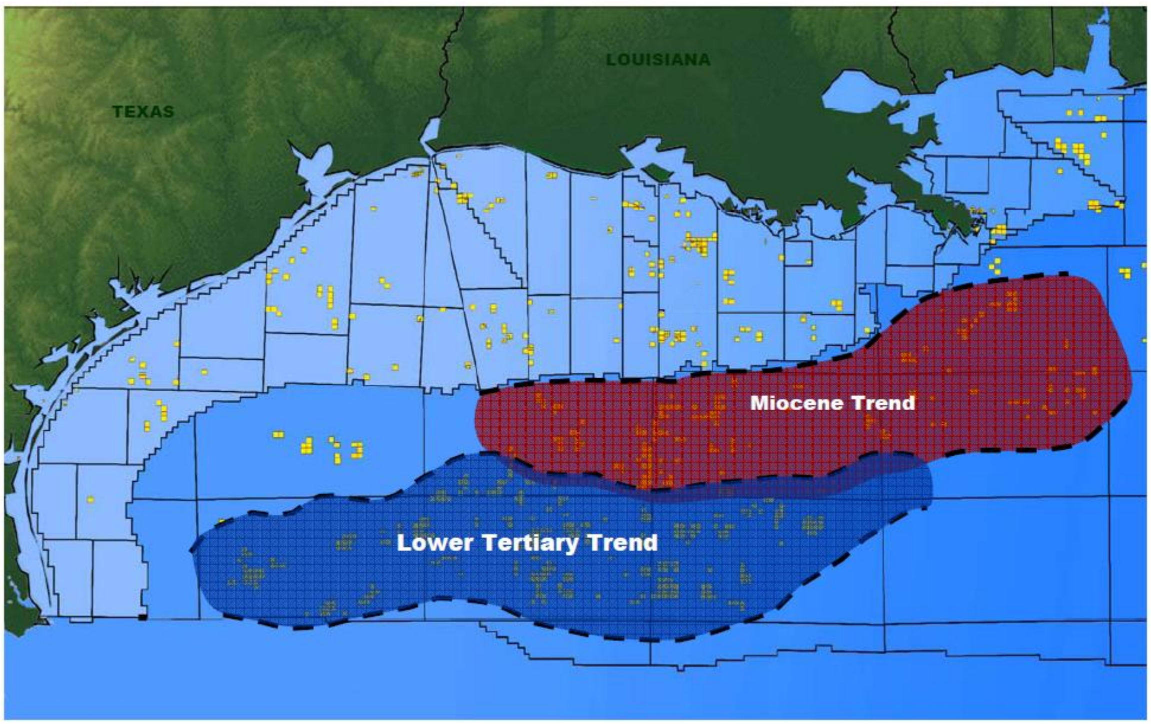


Addressing the environmental challenges requires technology and people technically apt to develop and apply new technology or develop processes that enable the use of existing technology. When operators lack proper technology to address the challenges, they will apply or modify existing technology as an alternative. This practice can make deepwater well construction more complex. When new technology is developed, its implementation can also complicate the well construction process. Developing technology able to withstand the extreme deepwater environments and perform faster, more accurate and more efficient is a challenge in itself for the industry. Producing this technology in quantities to meet demand such as deepwater rigs is another challenge. Properly and effectively applying new technology in operations is the last of these challenges but like capable rigs, people capable of developing and applying new technologies are scarce in the industry. This human capital deficit in the industry is being caused by the retirement of a large number of its engineers in what is being referred as the “Big Crew Change” (Irgens, 2008). The Big Crew Change is the departure of aging expert workers who are retirement eligible or are approaching that age, Baby Boomers. The effect the departure of senior workers has on the industry is intensified by the disproportionate small relief from the number of Generation X workers. Industry downturns and weak hiring when Generation X entered the workforce created a population deficit and the current disproportionate small relief coming in that age segment. According to some estimates in the U.S. there will be 35 million Generation X workers positioned to fill the gap left behind the 77 million Boomers (Rajan, 2007). The incoming and inexperienced Generation Y workers will need to fill the remaining gap in operations. This imbalance of capable personnel is a threat to operators’ ability to execute projects. Therefore, the challenge for the industry and deepwater operators is to assure Generation X workers assume leadership and mentorship roles necessary to expedite Generation Y's assimilation into the industry and their development of technical capabilities.

APPENDIX C - DWGOM OPPORTUNITIES

Regardless of the existing challenges, DWGOM offers great opportunities and it's a viable option for American operators to venture into. Declining reserves in the mainland, shallow waters and offshore restrictions on the west, east and Florida's coasts lead operators to explore DWGOM. In DWGOM, the Lower Tertiary geologic trend has also emerged as a play with great potential in deepwater exploration and production. Reports indicate that 99 percent of total GOM proved reserves are in Miocene and younger reservoirs, but recent exploration activities in deep water have discovered large reservoirs in sands of Lower Tertiary age (Richardson, Nixon, Bohannon, Kazanis, Montgomery, & Gravois, 2008). Operators are attracted by the fact that the size of DWGOM field discoveries has been several times larger than the average shallow-water field discoveries (Baud, Peterson, Doyle, & Richardson, 2000). To compliment the size of deepwater reservoirs, DWGOM exploration and development endeavors are further promoted by the U.S. governing agency. This agency provides royalty deduction reliefs for operators drilling in waters deeper than 800 meters and ten year leases instead of five year leases (shallow water) that allow operators to meticulously plan and prioritize their deepwater efforts. The aforementioned incentives and the fact that that the majority of DWGOM remains unexplored States side alone, demonstrate why DWGOM offers great amount of opportunity in its deep waters. Figure 2 presents the deepwater Miocene Trend and the ultra-deepwater Lower Tertiary Trend location in the GOM.

Figure 16 - Deepwater Miocene and Ultra-Deepwater Lower Tertiary Trend in GOM (Ford, Hollek, Oynes, Smith, Khurana)



Mexico's side of the GOM, while still constitutionally restricted only to PEMEX (Mexico's National Oil Company) is susceptible to allow foreign operators in its deep waters in the near future. This is because of rapid production declines in its primary fields without any new discoveries capable of offsetting those declines. The pressure for PEMEX to explore its deepwater to compensate for production decline is augmented by the perceived risk of loss of reserves through “drainage” by American-side endeavors near the U.S. – Mexico maritime border. Government incentives and the potential of Lower Tertiary plays have led American and foreign operators to pursue deepwater projects near this border on the American side of the GOM. Yet, PEMEX is considered to be ten years behind American GOM operators in deepwater competence so it can not pursue its own deepwater ventures to capitalize on these reservoirs being discovered. Not only is PEMEX not technically capable of pursuing deepwater projects alone, its economic suicide because of the great economic risks involved. Partnerships are the conventional method operators use to mitigate these risks; Mexican legislation prohibits PEMEX from entering the conventional partnerships, but PEMEX will need to partner up with other operators to mitigate the associated risks in deepwater projects. Essentially, DWGOM projects offer great appeal in the American side of the gulf today and offer great potential south of the border.

APPENDIX D – SCHEMATIC EXAMPLES OF DWGOM WELLS

Figure 17 - GOM Deepwater Casing Program: A Bird's Eye View (Close, McCavitt & Smith, 2008)

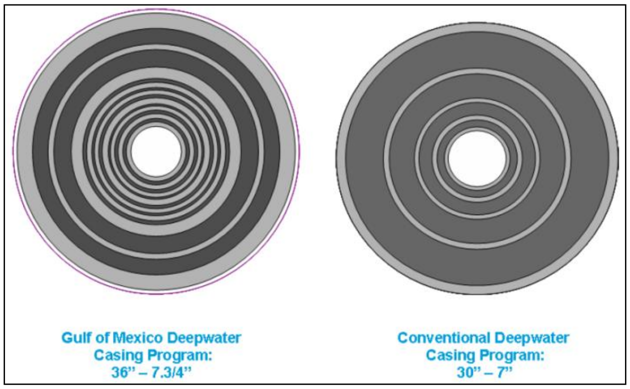


Figure 18 - Deepwater Wellbore Schematic (Watson, Lyoho, Meize & Kunning, 2005)

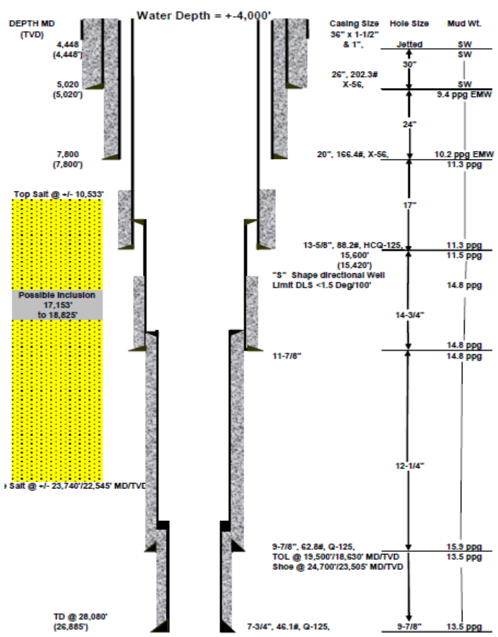
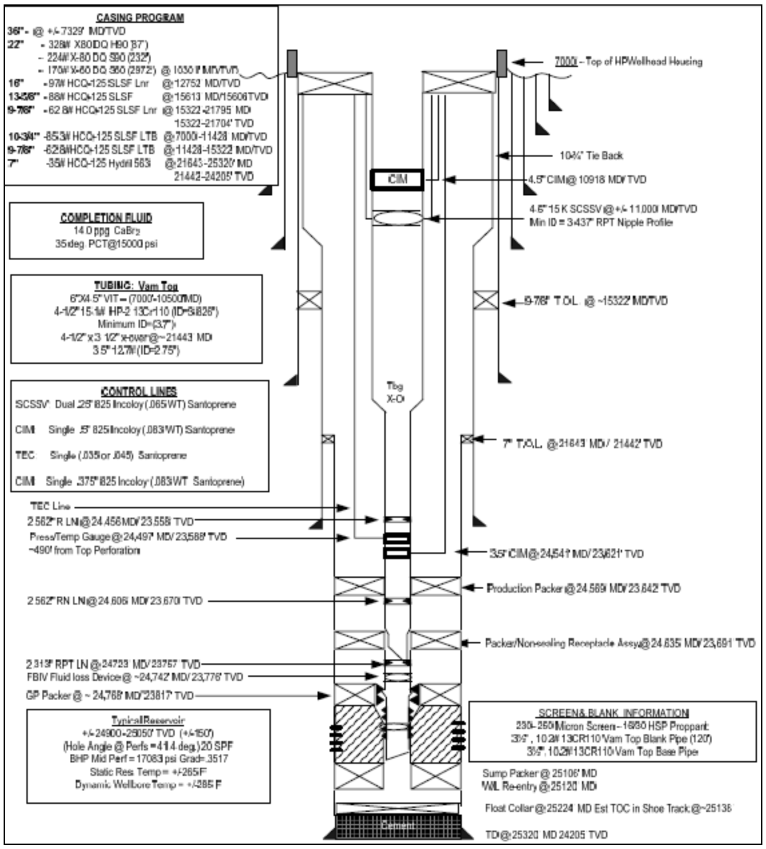


Figure 19 - Typical GOM Ultra-Deepwater Well Completion Schematic (Close, McCavitt & Smith, 2008)



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